REMARKS

This amendment is responsive to the Office Action of November 3, 2005. Reconsideration and allowance of claims 1-18 are requested.

The Office Action

Claims 1, 6, and 15 stand rejected under 35 U.S.C. § 112, first paragraph.

Claims 1-18 stand rejected on the new ground of rejection of Wood (US 2002/0070970) in view of Heuscher (US 5,544,212).

35 U.S.C. § 112

The Examiner asserts that the limitation of the first (thin) and second (thick) slices being parallel and viewed from the same direction is not described in the specification. To the contrary, page 8, lines 10-11, describe a preferred embodiment in which both the first or thin slices and the thick or second slices represent axial cross-section views. Since all of the thick and thin slices in this embodiment are axial sections parallel to a common plane, particularly the axial plane, they must all be parallel to each other.

It is submitted that viewing a plurality of axial slice images, which are inherently parallel to each other, inherently suggests viewing the slices from a common direction since. As shown in view port **510** of Wood, axial slice images are customarily viewed head on. Nonetheless, the applicants have cancelled this phrase because the phrase is unnecessary to patentability.

The References of Record

First, it is noted that the **Wood** published last August as US 6,925,200. It is suggested that the Examiner should make this patent of record, even though its disclosure is substantially redundant with the published application of record.

In Wood, note Figure 10, the patient is scanned **1010** to generate a series of "planar sections", each of which is identified by a "slice number". In the embodiment illustrated in the drawings of the application, the slices are axial sections or slices. The data from the body scan **110** is processed into the slices or CT sections at step **1020**. Wood does not describe any specific technique for this reconstruction.

One potential scanning and reconstruction technique is that shown in Heuscher, which is discussed below.

Each of the slices or planar sections are processed to identify and mark suspicious regions. Wood indicates that suspicious regions may be as small as 1 mm. If the slices are 1 mm thick, then to examine the lungs, as is done in Wood's preferred embodiment, then about 500 slices (if the lungs are half a meter long)would need to be evaluated. To facilitate this evaluation, Wood proposes that the evaluation step **1030** use the identified prior art segmentation and image filtering algorithms.

Next, at process **1040**, the slices are processed to create a volumetric view, preferably an offline computer different from the one on which the displays are generated. Wood does not describe the technique which he uses to generate this volumetric view. By viewing the volumetric view shown in Figure 13, it appears that the volumetric view may be a surface rendering of the interior of the lungs. That is, the step **1030** segmented the lungs in a segmentation process which apparently removed the tissue surrounding the lungs from the slice images as illustrated in view port **510**. For the display in port **520**, this segmented data is viewed and possibly projected onto a plane orthogonal to the planar sections or slices. In a maximum intensity projection, each slice is reduced to one line of image data on the volume image. Each pixel of the projected line has the intensity of the brightest or maximum intensity pixel underlying it. The actual slice that is displayed on view port **510** is displayed with a solid white line denoted by the arrow in Figure 13. As the arrow shown in view port of Figure 13 is moved or indexed up or down, the white line of Figure 13 moves accordingly. In this manner, the viewer is able to tell which of the slices through the lungs is being viewed on view port **510**. The regions of interest which were identified in step **1030** are defined by circles in the volume image shown in Figure 13.

View port **530** displays an enlarged surface rendered volume image of one of the identified regions of interest. It appears that the enlarged region on view port **530** may be a sphere corresponding to one of the circled regions on Figure 13. This volume image shows the surface contour of the lung. By rotating the volume, nodes and structures can be views from any direction. Of course, the view port **530** image shows only surface contour. One must refer back to the corresponding axial slice

displayed in view port **510** to get the gray scale or Hounsfield numbers corresponding to any point of interest.

Thus, the view ports **510**, **520**, and **530** display only one slice image and two volume images. One of the volume images is a surface rendering and the other may also be a surface rendered image or could be a maximum intensity projection or other volume image.

Heuscher is one of the early patents which relate to reconstructing spiral scan data. In spiral scanning, the patient moves continuously in an axial direction while the gantry rotates continuously about the patient. Detectors sampled simultaneously will generate data in a common plane, but one planar fan of data is not sufficient to reconstruct a CT image without serious artifacts. Each subsequent time that the detectors are sampled, the data which they represent is axially offset from the data in each of the preceding samplings. Moreover, in the earlier step-and-shoot technique in which the patient was scanned, moved or indexed a fixed distance, e.g., 2 mm., scanned again, indexed the same distance, scanned, etc., the slices or axial sections all had a fixed center-to-center spacing. If a center-to-center spacing of the slices is preselected in spiral scanning, there will be situations in which no data is sampled directly on one of the selected slices.

The "background" section of Heuscher, which the section upon which the Examiner appears to be relying, indicates that one prior technique for reconstructing this helical data uses linear interpolation. That is, for each of the mathematically defined rays through a selected slice, one looks for the closest corresponding ray to either side of the slice. Some pause of the closest rays will be offset only a very small distance axially, while others are axially offset a much larger distance. Heuscher points out that these reconstructed images had significant artifacts. Thus, if one defined the slices every 2 mm. and looked to use these slices for the final slice images, then the images would contain artifacts.

To avoid these artifacts, the prior art defined several slices for each slice, for example, 5 images on 0.4 mm. spacings. One then generated 5 images at 0.4 mm. spacing with artifacts and combined or summed the 5 together to reduce the artifacts. The end product of this reconstruction technique is again a series of slices on 2 mm.

centers, but with reduced artifacts. However, to achieve the advantage of reduced artifacts, the reconstruction time was increased 5-fold, in this example.

The Heuscher patent proposes a solution to this problem. Specifically, Heuscher proposes a reconstruction technique which reduces the artifacts, but with greatly accelerated reconstruction time. With reference to Figure 2, Heuscher proposes to define a filter function **70** whose center point is held centered on the center plane **74** of a selected slice with data to either side of the center plane **74** weighted according to the filter function and combined. In this manner, a larger amount of data is blended with the function **70** such that the image which is reconstructed with a single reconstruction operation is not artifacted.

Thus, the scanning step **1010** of Wood could have been a spiral scanning step and either the prior art or Heuscher technique could have been used in step **1020** of Wood to generate the series of axial images or slices which are displayed in view port **510**. Neither technique would have any effect on the operation, functioning, and display procedures set forth in Wood.

The Examiner's Application of the References

The Examiner asserts that Wood suggests displaying first image slices in a second view port and second image slices in a first view port and a superimposed version in a third. The applicants disagree. Axial slice images are displayed in view port **510**. A second view port **520** displays a **volume image** and view port **530** displays a magnified portion of the **volume image** in **520** (paragraph 43). None of the three displayed images is formed by superimposing the other two nor are any of the displayed images a superimposition of the other two. Indeed, only the image in view port **510** is a slice image; the images in view ports **520** and **530** are volume images.

The Examiner indicates that Wood does not explicitly teach that the slices are parallel and viewed from the same direction. To the contrary, the slices in slice display **510** are described as being axial sections or slices which are parallel. Moreover, Wood does not suggest viewing the slices in view port **510** in any way other than the illustrated orthogonal viewing direction.

The Examiner indicates that Heuscher discloses an imaging system which combines thin slices to form thick slices. Although not incorrect *per se*, it must be

recognized that the Heuscher procedure would be used in steps **1010** and **1020** of Wood, in which case Heuscher's so-called thick slices are the slices or axial sections which are displayed in view port **510** of Wood. Contrary to the Examiner's assertion, Heuscher does not address the viewing direction of the slices.

Wood makes no suggestion of combining or superimposing the displays set forth in viewing ports **510**, **520**, and **530**. If one were to sum, combine, or otherwise superimpose these three images, one would end up with the equivalent of a triple exposed photograph, in which the three images are superimposed on each other, obscuring each other's detail. It is submitted that such superimposed images would be diagnostically worthless. Accordingly, there is no motivation provided in any cited reference to superimpose these three displays.

The Present Application

As discussed above, if the slice images displayed in port 510 of Wood were each 1 mm. thick, 500 images would be needed to cover a 0.5 m. axial length. One could manually review each of these 500 pictures, looking for suspicious regions. However, reviewing 500 images would be time-consuming and tedious. To the contrary, Wood teaches that these images should be inspected by a computer algorithm.

The present application has a different approach. Many medical professionals are not comfortable with machine diagnoses as suggested by Wood. They prefer a human examination of the images.

The present application proposes to combine a plurality of contiguous images, such as sets of 10 continuous images, into a single thicker image. This reduces the number of slices which are displayed in one of the view ports of the present application from 500 (in the present example) to 50. The human operator then steps through these 50 thicker images looking for any abnormalities.

A second view port displays one of the thinner images which were combined to make the thick image. Which of the thinner images is displayed in the second view port is selectable. Thus, if the medical professional becomes suspicious from viewing either the thicker image or the one displayed thinner image, the medical professional can step through all 10 thinner images in the second view port. In this

manner, a thicker image made by combining 10 thinner images and one of the 10 thinner images are concurrently displayed. Of course, the number of images which are combined to make the thicker image may vary with the nature of the abnormality for which the medical professional is looking.

The present technique becomes even more valuable for whole body scanning. If a patient that is 2 m. tall is scanned with a whole-body scan that generates 1 mm. thick slices, then there are 2,000 slice images to examine. For 0.5 mm slices, there are 4,000 images. When doing a routine wellness scan, when no particular abnormality is expected, the thicker images are often sufficient. If an abnormality is suspected in one region of the patient, the medical professional can monitor and step through the thick images in the first view port until he/she reaches the region of interest. Once the region of interest is reached, the medical professional can turn his/her attention to the second view port and step through the thin images. After stepping through the region of primary interest, the medical professional can turn back to the first view port and return to viewing the thick images. Alternately, the thin slide images of the region of interest can be displayed in the first view port.

This concept of selectively viewing thicker images and thinner images of which each is constituted is not suggested by Wood or Heuscher.

<u>The Claims Distinguish Patentably Over the References of Record</u>

Claim 1 calls for generating and storing images of a first thickness. Wood makes no suggestion that the axial sections or slices generated in step **220** are other than a single thickness for any given patient scan. Similarly, in Heuscher, there is no suggestion that the slices stored in image memory **56** are any other than a single thickness. Claim 1 further calls for a data processor which combines subsets of the first images, i.e., the stored images, to generate a plurality of second image slices having a thickness greater than the first thickness. Wood makes no suggestion of combining subsets of the images generated in step **1020** and displayed on view port **510** into images of a second greater thickness. Heuscher alludes to a prior art reconstruction technique in which the image reconstruction process included generating thinner images which are combined to generate thicker images that are used for diagnostic purposes. Heuscher makes no suggestion of storing the thinner

images. Indeed, such images are noted as being artifacted. Rather, such thinner images are only an intermediate data processing step to the generation of the ultimate thicker image which is stored in image memory **56**.

Further, claim 1 calls for a display having a plurality of view ports including a first view port which displays the second, thicker images and a second view port which depicts the first or thinner slice images which are constituents of the displayed thicker image slice depicted in the first view port. Neither Wood nor Heuscher suggest displaying a thicker image and a thinner image concurrently. Moreover, neither Wood nor Heuscher teach or fairly suggest displaying a thick image which is made up of several thin images while one of the thin images of which it is made is displayed in a second view port. Wood displays one slide image in port **510** and volume images in ports **520** and **530**.

Accordingly, it is submitted that **claim 1 and claims 2-5 dependent therefrom** distinguish patentably and unobviously over the references of record.

Claim 6 calls for a first display which displays selected ones of thicker images and a second display which displays one or more thin images. Neither Heuscher nor Wood teach or fairly suggest displays or view ports which display thick and thin image in view port **510**. Heuscher only displays thick images. Wood displays a slice or axial section images. There is no suggestion in Wood that these axial sections or images are of different thicknesses. Further, display ports **520** and **530** display volume images, not slice images of any thickness.

Moreover, claim 6 calls for the first or thick images to be made by combining a plurality of the second or thin images. Thus, each thick image is made from a subset of n contiguous thin images. The second display means displays one of the first or thin images from the subset which was used to generate the second or thin image which is being displayed by the first display means. Neither Wood nor Heuscher suggest displaying one thick image and one of a subset of thinner images of which it is made while the thicker image is being displayed.

Accordingly, it is submitted that **claim 6 and claims 7-14 dependent therefrom** distinguish patentably and unobviously over the references of record.

Claim 15 calls for generating a plurality of second 2D images from subsets of first 2D images, then, during the display mode, the second images are

displayed sequentially for review by the reviewer. When designated regions of the subject are reached, the first images are displayed. Neither Wood nor Heuscher suggest sequentially displaying images which are made by combining subsets of first or thinner images before a designated region is reached and displaying the constituent 2D images from which the combined 2D images are made when the designated regions are reached.

Accordingly, it is submitted that **claim 15 and claims 16-18 dependent therefrom** distinguish patentably and unobviously over the references of record.

CONCLUSION

For the reasons set forth above, it is submitted that claims 1-18 distinguish patentably over the references of record and meet all statutory requirements. An early allowance of all claims is requested.

In the event the Examiner considers personal contact advantageous to the disposition of this case, she is requested to telephone Thomas Kocovsky at (216) 861-5582.

Respectfully submitted,

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